*भारतीय मानक*
***Indian Standard***

**IS 11329 : 2018**
**(Reaffirmed 2022)**

# कमरे में एयर कंडीशनर के लिए फिनड प्रकार के हीट एक्सचेंजर

*( पहला पुनरीक्षण )*

# Finned Type Heat Exchanger for Room Air Conditioner

*( First Revision )*

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Refrigeration and Air Conditioning Sectional Committee, MED 03

## FOREWORD

This Indian Standard (First Revision) was adopted by Bureau of Indian Standards, after the draft finalized by Refrigeration and Air Conditioning Sectional Committee had been approved by the Mechanical Engineering Division Council.

This revision has been contemplated in view of the technological advancement in the field of refrigeration and air conditioning globally and also advent of new environmental friendly refrigerants and phasing out of hydro fluoro carbon (HFC) refrigerants as per the directive from the policy makers and regulatory authorities.

Considering promotion of energy efficient house hold products and advanced technology in heat exchanger manufacture, smaller diameter copper and or aluminium micro channel have been recommended for the heat exchangers.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

# *Indian Standard*

# FINNED TYPE HEAT EXCHANGER FOR ROOM AIR CONDITIONER

## *( First Revision )*

## 1 SCOPE

This standard specifies the general requirement and method of tests for finned type heat exchangers used for the manufacturing of air conditioners of all types and sizes.

## 2 REFERENCES

The standards listed in Annex A have been referred in this standard. At the time of publication, the editions indicated were valid. All the standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

## 3 TERMINOLOGY

For the purpose of this standards the following terms shall apply.

**3.1 Heat Exchangers —** A device specifically designed to transfer heat between two physically separated fluids or mixtures of fluid.

**3.2 Evaporator —** A device used to turn the liquid form of a chemical into its gaseous form. The liquid is evaporated, or vaporized, into a gas.

**3.3 Condenser —** Where the heat exchanging fluid rejects heat and changes from gaseous phase to liquid phase.

**3.4 Design Pressure —** The pressure used in design calculations for the purpose of determining the minimum thickness of the various components like suction, discharge and liquid refrigerant piping. It is obtained by adding a minimum of ten percent for any other figure as may be agreed to between the purchaser and the manufacturer to the maximum working pressure.

NOTE — Considering the wide range of temperature profiles in India it is recommended that while designing the air conditioners, ambient temperature prevailing in different parts of the country may be considered.

**3.5 Maximum Working Pressure —** It is the maximum pressure that any part of the heat exchanger attains in its operating range for the intended use of Evaporator and condenser.

**3.6 Design Stress —** The maximum stress from all sources permitted for the materials of construction at the design temperature.

a) Stress due to bending of the tube for the fabrication of coil before installation and assembly
b) Stress due to heating of joints while brazing
c) Stress while pressure testing

**3.7 Design Temperature —** The temperature considered in design of the heat exchanger for determining the minimum thickness of the component parts of the exchanger. It is taken as 10°C higher than the maximum temperature that any part of the heat exchanger in its intended usage is likely to attain in the course of its operation.

NOTE — The maximum permissible operating fluid temperature for pressure parts is 160°C.

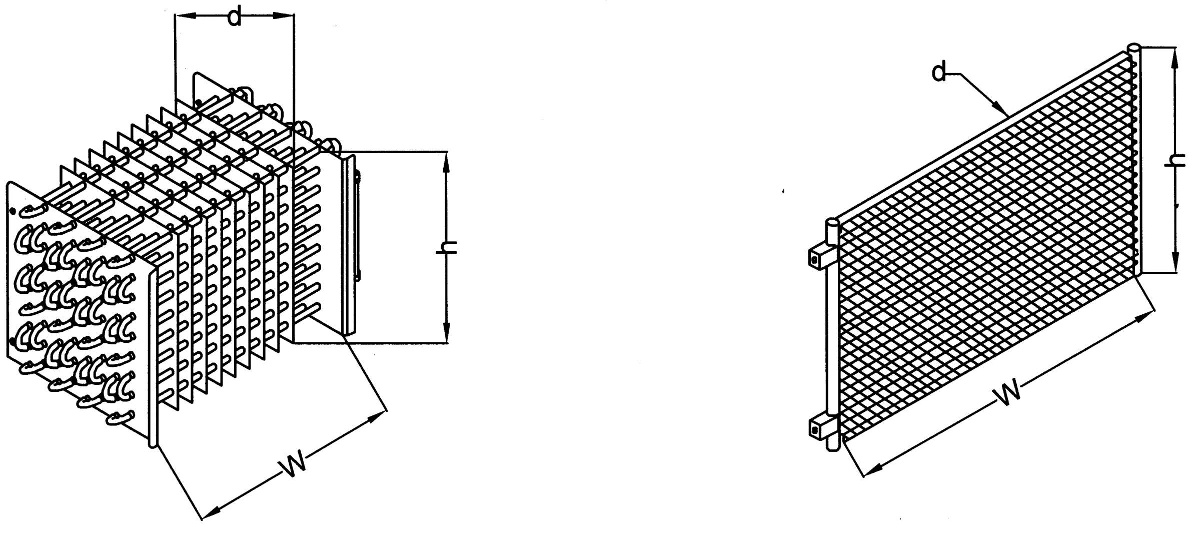
**3.8 Nominal Width —** Nominal width (*w*) of heat exchanger shall be the width of the heat exchanger between the two tube sheet / end plates (fin pack with collar and tube type heat exchanger as shown in Fig. 1 A) or it shall be the width of heat exchanger between two headers (micro channel tube type heat exchanger as shown in Fig. 1 B) in millimetres rounded off to nearest integer.

**3.9 Nominal Height —** Nominal height (*h*) shall be the height of the heat exchanger of finned surface/ individual fin (fin pack with collar and tube type heat exchanger as shown in Fig. 1 A) or it shall be the height of heat exchanger between two endplates (micro channel tube type heat exchanger, as shown in Fig. 1B) in millimetres.

**3.10 Nominal Depth —** Nominal depth (*d*) shall be the depth of the heat exchanger of finned surface / width of the individual fin (fin pack with collar and tube type heat exchanger as shown in Fig. 1 A) or it shall be width of micro channel tube/continuous fin (micro channel tube type heat exchanger as shown in Fig. 1 B) in millimetres.

**3.11 Nominal Tube Diameter (Fin Pack with Collar and Tube Type) —** Nominal tube diameter shall be the outside diameter of the individual tube.

**3.12 Nominal Tube Width and Tube Height (Micro Channel Type) —** Nominal Tube width and Tube height shall be outside tube width and tube height of the individual tube.



1A Fin Pack with collar and Tube Type Heat Exchanger

1B Micro Channel Type Heat Exchanger

FIG. 1 NOMINAL WIDTH, HEIGHT AND DEPTH TERMINOLOGY OF 1A AND 1B

**3.13 Fin Pitch** — It is the distance between two fins in millimetres.

**3.14 Tube Sheet/End Plate/Side Plate** — Tube sheet/ end plate is a sheet metal part, provided to give strength to the fin and tube assembly.

**3.15 Enhanced Fin Surface** — Enhanced fin surface is a method of increasing air side heat transfer either by increasing the fin surface area (sine wave or V waffle) or by providing increased air turbulence by using louvered (slit) / raised lanced surface (super slit).

**3.16 E-Coating (Electro Coating)** — E-Coating is the method of deposition of material with opposite electrical charge on the outside and exposed surface of the heat exchanger for protection against harsh environmental conditions.

**3.17 Fin Pattern** — It is arrangement of tube pitch ($X_t$-transverse and $X_l$-lateral) in plate fin with collar and tube arrangement. Tube arrangement in fin pattern can be equilateral or isosceles triangle as shown in Fig. 2.

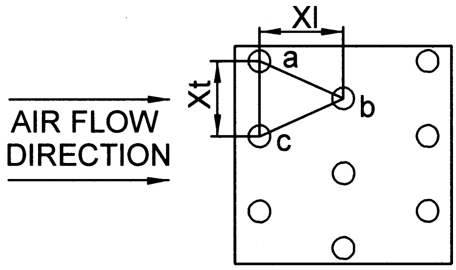


FIG. 2 FIN PATTERN (FIN PACK WITH COLLAR TUBE TYPE)

## 4 CLASSIFICATION AND NOMENCLATURE

Finned tube heat exchangers can be classified based on the heat exchanger construction and fin enhancements.

### 4.1 Classification by Construction Method

Heat exchanger can be classified based on the method of construction as follows :

a) Fin pack with collar and tube type, and
b) Micro channel tube with continuous fin type.

**4.1.1** *Fin Pack with Collar and Tube Type*

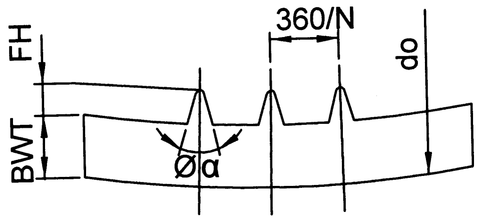
These types of heat exchangers are made of plate fin packs with collar and tubes. These heat exchangers are manufactured by expansion of collar fin packs and tubes assembly. These can be further classified based on fin / tube material, tube type (Plain tube and inner grove tube) and by types of enhanced fin surfaces.

**4.1.1.1** *Copper tube aluminium fin (CTAF)*

These types of heat exchangers are made of copper tube and aluminium plate fins packs with collar.

**4.1.1.2** *Copper inner groove/micro groove tube and aluminium fin*

These types of heat exchangers are made of inner grooved copper tube (IGT) (Outer dia > 5 mm) or micro groove copper tube (Outer dia < 5mm) and aluminium plate fins with collar packs.



FH - Fin Height, BWT - Bottom Wall Thickness, do - Outer Diameter of Tube, a- Fin Angel

FIG. 3 CUT SECTION INNER GROVE TUBE (IGT)

**4.1.1.3** *Aluminium tube and aluminium fin (ATAF)*

These types of heat exchangers are made up of aluminium tube and aluminium plate fin packs with collar.

**4.1.1.4** *Enhanced fin surfaces*

Various types of enhanced fin surfaces based on fin, tube material and type are described below:

a) Surface/edge enhanced fin — Sine wave, V waffle and rippled edge type.
b) Louvered fin/slit fin — Fin surface are slit and raised at an angle.
c) Raised lanced/super fin — surfaces have slits which are raised above the fin surface.

**4.1.2** *Micro Channel Aluminium Tube and Aluminium Fin Heat Exchanger (MCHE)*

MCHE shall be made with flat micro channel tube, fins and two refrigerant manifolds / headers as shown in Fig. 4

### 4.2 Nomenclature

For the purpose of this standard, different parts of heat exchangers shall be designated as follows :

a) Straight tube,
b) Hairpin tube,
c) Inner grooved tube (IGT) and micro grooved tube,
d) Micro channel tube,
e) Plain plate fin with collar,
f) Enhanced plate fin with collar,
g) Continuous fin,
h) Return bends,
j) ‘C’ bends,
k) ‘U’ bends,
m) Tube sheet / End plate / Side plate,
n) Inlet header,
p) Outlet header,
q) Header (for MCHE application),
r) Inlet connection,
s) Outlet connection, and
t) Mounting bracket (for MCHE application).

## 5 MATERIALS

### 5.1 Tube Material

The material for the tube shall be of copper or aluminium and shall conform to the relevant standards as described below:

a) *Copper tube* — Copper tube shall be deoxidized high residual phosphorous copper material and shall conform to IS 10773.
b) *Aluminium tube* — Aluminium tube material shall conform to IS 737. Normal used grades are 51000B / Equivalent aluminium alloy grade AA 3003
c) *Aluminium micro channel tube* — Aluminium tube material shall conform to IS 737. Normal used grades are AA 19002 coated outside with zinc amount with recommended value of 10gm/m$^2$.

### 5.2 Fin Material

The material for the fin shall be of aluminium and shall conform to the relevant Standards as given below:

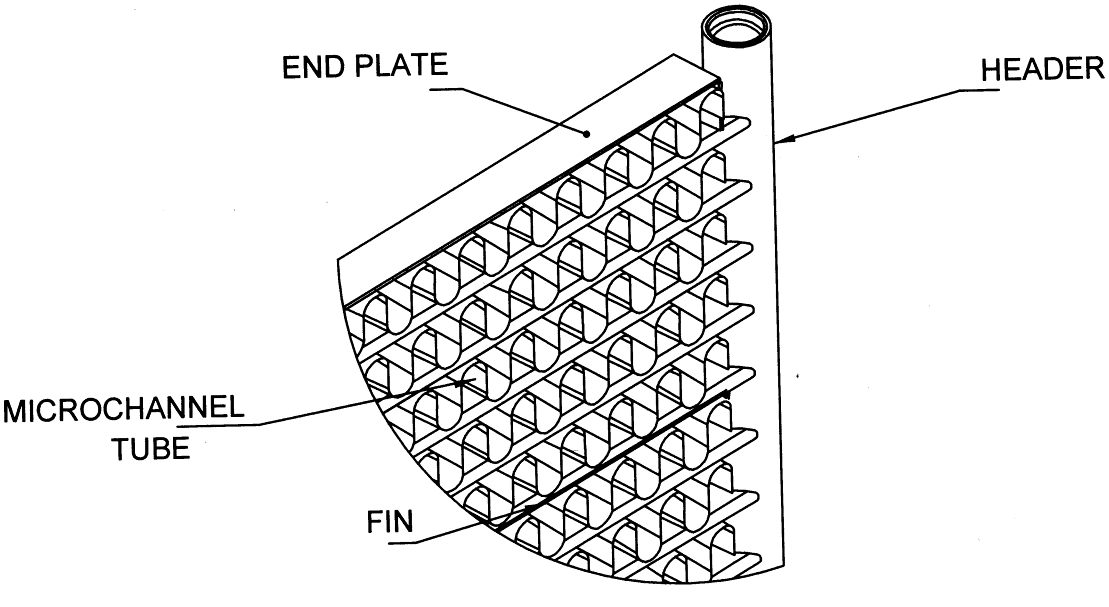


Fig. 4 Microchannel Heat Exchanger (Cut Section)

a) *Aluminium fin* — Aluminium fin material shall conform to IS 737. Normal used grades are 52000 / Equivalent aluminium alloy grade AA 8011.

b) *Aluminium clad fin material* — Aluminium fin material normal used grade is AA 3003 with AA 4343 clad 10 percent on both side.

### 5.3 Tube Sheet /End Plate

The material for the tube sheet and end plate shall conform to the relevant standards as described below:

a) *Zinc coated GI sheet* — Tube sheet/end plate material shall conform to IS 277. Normal used zinc coating is 275 g.

b) *Aluminium sheet* — Aluminium tube material shall conform to IS 737. Normal used grades are 19000, 52000, 52300 and 52300B / Equivalent aluminium alloy grade AA 1100, AA 1200, AA 5049, AA 5051, AA 5052.

## 6 QUALITY REQUIREMENTS

### 6.1 Visual Inspection

Visible surfaces must be clean and without porosity, inclusion, incident points, scratches, scrapes, etc. Heat exchangers inlet and outlet tube ends shall be closes with rubber grommet or plugs to avoid entering of any dust or liquid inside the tubes.

### 6.2 Construction

**6.2.1** *Fin Pack with Collar and Tube Type Heat Exchanger (Expanded Tubes)*

**6.2.1.1** *Hairpin tube*

Overall length of hairpin, which is the average of both legs shall be within of the nominal hairpin length (include shrinkages) indicated on the hairpin drawing.

The leg length difference of any hairpin should not exceed 1mm.

Grooves and scratches are not allowed which may be detrimental to the burst strength, function or appearance of the hairpin. Hairpins assembled into coils should be able to withstand pressure resistance tests as described in **7.2.**

There shall be no sharp edges and the hairpins shall be properly deburred and free from chips and sawdust.

**6.2.1.2** *Fin forming*

Fins shall be formed in such a manner that no excessive wrinkling occurs around the base of the fin collar or in Innerdia of the collar. Collars shall have no splits, tears or cracks.

**6.2.1.3** *Tube sheet/End plate*

Tube sheet / end plate holes shall be effectively free from interior burrs or sharp edges (max burr height is 10 percent of material thickness), which has the potential to pierce the copper/ aluminium tube, causing minute leaks. Tube sheet / end plate holes sizes shall be checked with a plug gauge as per Table 1 given below:

**Table 1 Tube sheet hole sizes**

(*Clause* 6.2.1.3)

| **Sl No.** | **Tube Outer Dia** mm | **Hole Size** mm |
|---|---|---|
| (1) | (2) | (3) |
| i) | 5.0 | $5.3^{+0.02}_{-0.00}$ |
| i) | 7.0 | $7.4^{+0.02}_{-0.00}$ |
| iii) | 9.52 | $10.0^{+0.02}_{-0.00}$ |
| iv) | 12.7 | $13.2^{+0.02}_{-0.00}$ |

**6.2.1.4** *Expanded fin tightness*

The copper/aluminium tube should be expanded to D + 0.1 mm minimum to get a firm bonding between aluminium fin pack and copper/aluminium tubes. *D* is the hole diameter of the aluminium fin in millimetre.

To check proper bonding between copper / aluminium tube and fin pack, take out a sample coil out of a batch of 100. Cut out a piece of 50 mm × 50 mm and pull out the aluminium fins and check visually. If there are clear scoring marks on the tube, the bonding is proper.

**6.2.1.5** *Brazing material selection*

Brazing material shall confirm to IS 2927, selected accordingly as per application requirements,

a) Cu-Cu joint : Recommended grades are BA CuP2 , BA CuP3 , BA CuP4

b) Cu-Al joint : Recommended grade is BA A1 Si3

c) Al-Al joint : Recommended grade is BA A1 Si3

**6.2.1.6** *Brazing joint*

The following points should be followed for good brazed joint quality:

a) *Joint gap* — Recommended joint gap for Cu-Cu: 0.00 to 0.05mm, Cu-Al: 0.05 to 0.2mm and Al-Al: 0.05 to 0.15mm.

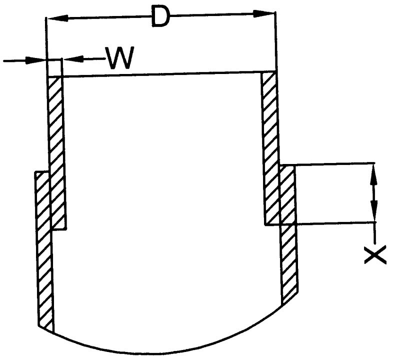
b) *Joint overlap (length)* — Joint overlap (length) between two tubes joints shall be maintained as per equation shown in Fig. 5.

c) Brazing joints should be effectively free from oil traces.

d) Appropriate flux to be used to prevent oxide formation during brazing process.

e) Inert gases shall be used for purging during brazing to avoid oxidation and contamination internally.

f) Brazing joints shall free from residual flux to prevent atmospheric corrosion.



X = W (D-W) TCLD X = Length of Lap Area, W = Wall Thickness of Weakest Member,
D = Diameter of Lap Area, T = Tensile Strength of Weakest Member, C = Joint Integrity Factor of 0.8, L = Sher Strength of Brazed Filler Metal

FIG. 5 JOINT OVERRAIL LENGTH CALCULATION

**6.2.2** *MCHE-Micro Channel Heat Exchanger (Furnace Brazed Coils)*

All the components and the material used in the heat exchanger assembly, namely, tube, header, side plate, fins and core assembly in the heat exchanger assembly shall be free from burrs.

**6.2.3** *Heat Exchanger Assembly*

Heat exchanger assembly after brazing shall have,

a) brazing joint contact quality > 95 percent of tube-fin brazed contact area and fin-side plate brazed contact area independently.
b) brazing fillet joint quality shall be agreed between the purchaser and the manufacturer.
c) no fin burn allowed.
d) fin drop shall be < 1mm in condenser assembly.

## 7 TESTING

### 7.1 Permissible Assembly Contamination Specification

**7.1.1** *Internal Contamination*

Total residue contamination is maximum 100 mg/m$^2$ of total internal surface area of which,

40 mg/m$^2$ *max* may be soluble and 60 mg/m$^2$ *max* may be insoluble.

Test method:

Take glass beaker, conical flask should be cleaned previously with the solvent solution and dry in an oven at 105 to 110 °C. After drying, let the flask became cold, weight them in a precision balance with at least 0.000 0 g resolution and keep the results. The paper filter or glass filter pan to be used has to be dry and has to be weighted in a precision balance.

a) Take solvent in beaker as per internal volume.
b) Fix one plastic pipe to inlet tube of heat exchanger and one pipe in outlet tube.
c) Put the end of the pipe inside the beaker with solvent and make it pass through the complete heat exchanger.
d) Wait for 10 min. During this time, solvent agent acts and all the internal residues become dissolved then collect from outlet tube of heat exchanger to flask.
e) Take the solvent agent and filter it through filter paper or glass filter pan.
f) Put the flask with the liquid into an oven at around 80ºC until all the solvent agent gets evaporated (this process will take some hours).
g) Take the flask after evaporation and wait until it gets cold (ambient temperature).
h) Weight the flask in a precision balance and keep the result.
j) Weight the paper filter or glass filter pan in a precision balance and keep result.

Soluble residue

$$= \frac{\text{Flask weight after test} - \text{Flask weight empty}}{\text{Internal surface area of heat exchanger}}$$

Non soluble residue

$$= \frac{\text{Filter weight after test} - \text{Filter weight before test}}{\text{Internal surface area of heat exchanger}}$$

**7.1.2** *Moisture Content*

Allowable moisture content shall be 50 mg/m$^2$ of total internal surface area as per Karl Fisher Titration method described below:

a) Switch 'ON' the oven at around 55 °C temperature.
b) Switch on coulometer, select working mode and then press start key.
c) Open nitrogen cylinder and keep flow 200 cm.
d) Let the coulometer stabilize. When shows ready put heat exchanger inside the oven and let the heat exchanger stabilize for 30 min approximately.
e) Press start key and enter sample size. Usually sample size is being kept 1.0 g.
f) Connect one end of heat exchanger with nitrogen pipe and other end of it with coulometer.

g) Press enter key and wait till reading gets stabilize.

h) Note down the $H_2O$ reading shows in screen, it is moisture content.

j) Remove heat exchanger and switch off instruments.

### 7.2 Pressure Test for Assembly Tightness

Each coil shall undergo leak test to conform tightness specification as per IS 9902. Leak test method is either water leak test or helium leak test is described in **7.2.1** and **7.2.2.**

**7.2.1** *Water Leak Test*

All coils shall be subjected to dry nitrogen or dry air with test pressure as given in Table 2 for water leak test purpose. The test shall be carried as described below:

a) Close one end with dead end plug and provide shut off valve on the other end of the test sample.

b) Connect the coupler to the other end and pressurize charge with dry nitrogen or dry air as specified.

c) Submerge the coil assemble in water tank and hold for 1min. Check for the bubble leakage.

**Table 2 Refrigerant and Corresponding Test Pressure**

(*Clause* 7.2.1)

| Sl No.<br>(1) | Refrigerant Used<br>(2) | Chemical Formula<br>(3) | Test Pressure ( kPa )<br>(4) |
|---|---|---|---|
| i) | R 22 | HCFC – $CHCIF_2$ | $2\,750^{+50}_{-0}$ |
| ii) | R 32 | HFC – $CH_2F_2$ | $3\,800^{+50}_{-0}$ |
| iii) | R 290 | Propane – $C_3H_8$ | $2400^{+50}_{-0}$ |
| iv) | R 410A | R32/R125 (50/50) | $3600^{+50}_{-0}$ |

NOTE — There shall not be any leakage after the pressure test.

**7.2.2** *Helium Leak Test*

Helium is being used as tracer gas, sensitive to detect minute leaks in heat exchanger assemblies. Leak testing is being done by chamber test method as specified in **7.2.2.1**.

Leak rate specification:

At 40 bar – 6 5.05 × $10^{-5}$ mbar·l/s

At 30 bar – 2.87× $10^{-5}$ mbar·l/s

**7.2.2.1** *Chamber test method (see Fig. 6)*

Vacuum chamber evacuation — The heat exchanger is inserted in a leak tight chamber and chamber evacuated under vacuum environment condition.

a) Heat exchanger is filled with nitrogen to a minimum pressure of 40 bar to test the mechanical resistance of components and joints. This will detect breakages leading to leakages, or large leaks already existing on the heat exchanger. Nitrogen is removed from the heat exchanger.

b) Heat exchanger is evacuated to 100 mbar to check the medium size leakage in heat exchanger.

c) Heat exchanger is charged with helium (He) with pressure of 40 bar (This pressure with helium is regardless of the type of refrigerant used. To establish limits it is calculated the equivalence between maximum leakage rate of the appliance at the average working pressure and the helium leakage at the testing pressure of the chamber at 40 bar.) The Helium detection system available in the hermetic chamber detects small leaks of this Helium gas coming out of heat exchanger.

The leak to be carried out as mentioned above shall conform to IS 9902.

### 7.3 Test for Mechanical Strength

The pressure resistance is done to check the mechanical strength (resistance against bursting) of the coil. The heat exchanger assembly is subjected to either one to be followed as strength or fatigue strength test as per details given below

**7.3.1** *Burst Test*

Two samples of each type of component are to be tested.

a) Heat exchanger shall withstand 3 times the design pressure of the heat exchanger on the low pressure side

b) Heat exchanger shall withstand 5 times the design pressure of heat exchanger on the high pressure side

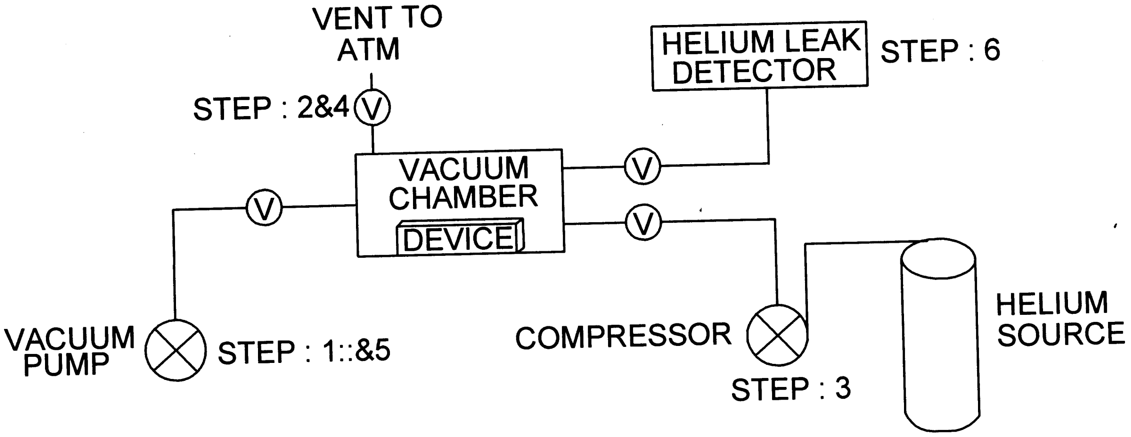
Test method and requirement:

The test samples are to be filled with water to exclude air and are to be connected in a hydraulic pump system. The pressure is to be raised gradually until the highest pressure as required by a) and b) is reached. This pressure is to be maintained for 1 min, during which time the sample shall not burst or show visible leakage.

**7.3.2** *Fatigue Strength Test*

One sample of each type of component is to be tested. This is a cyclic test consisting of 250 000 cycles. The test method and the requirements are described below:

a) 1st cycle, the test samples are to be filled with water to exclude air and are to be connected



Step 1 : Evacuate Chamber
Step 2 : Vent Chamber to Atmosphere
Step 3 : Pressurize Chamber with Helium
Step 4 : Vent Chamber to Atmosphere
Step 5 : Evacuate Chamber
Step 6 : Residual Gas Analysis to Detect Helium

FIG. 6 HELIUM TEST LINE DIAGRAM

in a hydraulic pump system. The pressure is to be raised gradually until the highest pressure as required by a) and b) is reached. This pressure is to be maintained for 1 min.

b) 2nd to 250 000 cycle are the pressure within each sample shall be raised and lowered such that the full specified upper and lower pressure cyclic values are maintained for at least 0.1s.

c) *Cycle test pressure* — Heat exchanger is subject to high side pressures, the upper pressure value shall not be less than the saturated vapour pressure of the refrigerant at 49°C, and the lower pressure value shall not be greater than the saturated vapour pressure of the refrigerant at 4.4°C.

After completion of the test, heat exchanger shall withstand 1.5 time design pressure and there should not be any visible leak and burst.

In addition to the above test, heat exchanger shall withstand the 3 time design pressure prior to cycle test and there should not be any visible leak or burst.

### 7.4 Test for Corrosion Resistance

**7.4.1** *General Requirements*

The material for the heat exchanger shall be corrosion resistant and shall be treated appropriately with anti-corrosive protection material to prevent damage or leakage due to oxidation effect due to presence of any pollutant in the surroundings. Any protective coating shall be agreed between purchaser and the manufacturer like lacquers, powder coat, cathode electric deposition, etc.

**7.4.2** *Type of Corrosion*

The two type of corrosion in HVAC heat exchangers are localized or galvanic corrosion and general corrosion as given below.

a) *Galvanic corrosion* — Galvanic corrosion occurs when dissimilar metals, in contact are exposed to electrolyte.

b) *General corrosion* — General corrosion is the degradation of metal caused by a reaction with the surrounding environment.

**7.4.3** *Type of Environment*

Environment consists of contaminants and dust particles, which results in creating electrolyte. These electrolytes facilitate the corrosion process. Various types of corrosive environments are as,

a) *Coastal/Marine* — Environment contains tiny droplets of sea salt, which results into sodium chloride and sulphur contamination.

b) *Industrial* — Environment contains industrial exhaust, which results into sulphur oxides ($SO_2$, $SO_3$) and nitrogen oxides (NOx) contamination.

c) *Urban* — Environment contains local urban influence of open sewage system / vents / diesel exhaust and emission from dense traffic and dust particles.

**7.4.4** *Selection of Material base on Environmental Condition*

Based on the environment, following bare / protective coatings shall be used. Any special protective coating shall be as agreed to between the purchaser and the manufacturer:

a) *Bare aluminium fin and zinc coated tube sheets* — Recommended for mild urban environment.
b) *Bare aluminium fin and aluminium tube sheets* — Recommended for corrosive environment during sea shipment.
c) *Pre coated aluminium fin and zinc coated tube sheets* — Pre coated fin material is fin stock coated prior to the fin stamping process. Recommended for mildly corrosive coastal / urban - local environment (open sewages system)
d) *Cathode electric deposition* — Coated heat exchanger (under category of classification by type: 4.1): It is a special coating for highly corrosive atmosphere that is severe coastal / marine / industrial / sewage environments.

**7.4.5** *Test Method and Requirement*

**7.4.5.1** *Test method*

Various environmental tests like hydrogen sulphide, sulphur dioxide, salt mist, damp heat, dust, temperature humidity cycle dry tests etc as per IS 9844 and IS 9000 series of standards shall be carried out.

**7.4.5.2** *Test requirement*

The following tests carried out to ensure the air conditioner performs effectively under various atmospheric conditions.

a) Salt spray test shall be as IS 9844 and humidity test shall be as per IS 9000 (Part 11).
b) Dust choking test shall be as per IS 9000 (Part 12).

   Damp heat cycle test and environmental test to conform IS 9000 (Part 5/Sec 1 and 2).
c) Cooling capacity test shall be as per IS 1391 (Part 2).

Salt spray life test hours shall be agreed between purchaser and manufacturer. After completion of test, heat exchanger shall confirm to assembly tightness specification.

## 8 MARKING

### 8.1 Marking of Finned Type Heat Exchanger

Each finned type heat exchanger for room air conditioners shall be marked with the following:

a) Type of construction;
b) Serial number of the heat exchanger;
c) Dimensions (L) × (W) × (H);
d) Working pressure ;
e) Weight, in kg;
f) Capacity of air-conditioner suitable for the heat exchanger; and
g) Country of manufacture.

The information/details as mentioned above shall be provided with inkjet printer or equivalent quality printing. Any other additional marking shall be as agreed between the manufacturer and the purchaser.

NOTE — The requirement of the marking details is applicable for heat exchangers procured from outside sources by the AC manufacturers. In case the heat exchanger is manufactured in house, in that case the such marking is optional. However, the manufacturer of air conditioners shall ensure the traceability of the heat exchanger used with respect to its test results, batch number/lot number, etc.

### 8.2 BIS Certification Marking

Each finned type heat exchanger for room air conditioners may also be marked with the Standard Mark.

**8.2.1** The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards* Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

## 9 TYPE TEST AND ROUTINE TEST

### 9.1 Type Test

The type tests are conducted once in a year to validate product conformance to standards. All the tests specified in this standard are type tests.

### 9.2 Routine Test

Routine tests are conducted for production parts on 100 percent basis and lot wise basis to conform production part quality. Typical 100 percent production routine tests are visual inspection and assembly leakage test and lot wise routine tests are assembly level contamination and moisture test.

## ANNEX A

(*Clause* 2)

### LIST OF REFERRED INDIAN STANDARDS

| *IS No.* | *Title* |
|---|---|
| 277 : 2003 | Galvanized steel sheets (plain and corrugated) (*sixth revision*) |
| 737 : 2008 | Wrought aluminium and aluminium alloys sheet and strip for general engineering purposes (*fourth revision*) |
| 1391 (Part 2) :1992 | Room air conditioners : Part 2 Split air conditioners (*second revision*) |
| 2927 : 1975 | Specification for brazing alloys (*first revision)* |
| 9000 | Basic environmental testing procedures for electronic and electrical items |
| (Part 5/Sec 1 and Sec 2) : 1981 | Damp heat cyclic test |
| (Part 11) : 1983 | Salt mist test |
| (Part 12) : 1981 | Dust test |
| 9844 :1981 | Methods of testing corrosion resistance of electroplated and anodized aluminium coatings by neutral salt sprays |
| 9902 : 2004 | Recommended practices for leak testing (*first revision*) |
| 10773 : 1995 | Wrought copper tubes for refrigeration and airconditioning, purposes (*first revision*) |

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This Indian Standard has been developed from Doc No.: MED 03 (1388).

**Amendments Issued Since Publication**

| Amend No. | Date of Issue | Text Affected |
|---|---|---|
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Published by BIS, New Delhi

# AMENDMENT NO. 1 JANUARY 2020

# TO

# IS 11329 : 2018 FINNED TYPE HEAT EXCHANGER FOR ROOM AIR CONDITIONER

( *First Revision* )

(*Page* 1, *clause* **1**) — Substitute the following for the existing clause:

‘**1 SCOPE**

This standard specifies the general requirement and method of tests for finned type heat exchangers used for the manufacturing of room air conditioners up to and including capacity of 10 500 W.’

(*Page* 1, *clause* **3.4**) — Substitute the following for the existing clause:

‘**3.4 Design Pressure** — Pressure chosen for the strength calculation of each component.

NOTES

**1** It is used for determining the necessary materials, thickness, and construction for components with regard to their ability to withstand pressure.

**2** Considering the wide range of temperature profile in India it is recommended that while designing the air conditioners, ambient temperature prevailing in different parts of the country may be considered.’

(*Page* 1, *clause* **3.7**) — Delete.

(*Page* 2, *Fig.* 1) — Insert the following note under figure:

‘NOTE — Fig. 1A and Fig. 1B is for reference only.’

(*Page* 2, *clause* **3.16**) — Delete.

(*Page* 2, *clause* **3.17**) — Substitute the following for the existing clause:

‘**3.17 Fin Pattern** — It is an arrangement of tube pitch in plate fin with collar and tube arrangement.’

(*Page* 2, *Fig*. 2) — Delete.

(*Page* 2, *clause* **4.1.1**) — Substitute '*Fin Pack with Collar and Tube Type (FTHX)' for* '*Fin Pack with Collar and Tube Type'*.

(*Page* 2, *clause* **4.1.1.2**) — Substitute the following for the existing clause:

'**4.1.1.2** *Copper inner groove / micro groove tube and aluminium fin (IGAF)*

These tubes of heat exchangers are made of inner grooved copper tube (IGT) or micro grooved copper tube and aluminium plate fins with collar packs.'

(*Page* 2, *Fig*. 3) — Insert the following note at the end of figure:

'NOTE — Figure 3 is for reference only.'

(*Page* 3, *clause* **4.1.1.4**) — Substitute '*Enhanced fin surfaces* (*EFST*)' *for* '*Enhanced fin surfaces'*.

(*Page* 3, *clause* **4.1.2**) — Substitute '*Micro Channel Aluminium Tube and Aluminium Fin Heat Exchanger* (*MCHX*)' *for* '*Micro Channel Aluminium Tube and Aluminium Fin Heat Exchanger* (*MCHE*)' in the title.

(*Page* 3, *Fig*. 4) — Substitute the following for the existing figure:

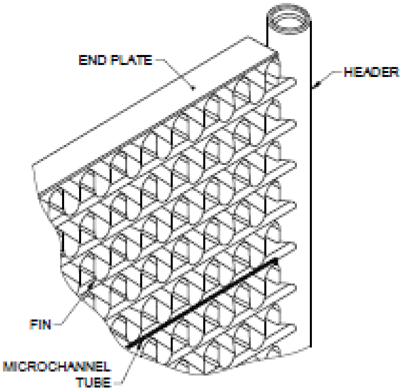

FIG. 4 MICROCHANNEL HEAT EXCHANGER (CUT SECTION)

(*Page* 3, *clause* **5.1**) — Substitute the following for the existing clause:

**‘5.1 Tube Material**

The material for the tube shall be of copper or aluminium and shall conform to the relevant standards as described below:

a) *Copper tube* — Copper tube shall conform to IS 10773 or International standard for copper tube used in air conditioner.

b) *Aluminium tube* — Aluminium tube material shall conform to IS 737or International Standard for aluminium tube used in air conditioner.

c) *Aluminium microchannel tube* — Aluminium tube material shall conform to IS 737 or International standard for aluminium tube used in air conditioner.

NOTE — Suitable material other than Al/ Cu may be used as per manufacturers design.’

[*Page* 4, *clause* **5.2** a)] — Substitute the following for the existing clause:

a) *Aluminium fin* — Aluminium fin material shall conform to IS 737 or International Standard.

[*Page* 4, *clause* **5.2** b)] — Delete.

[*Page* 4, *clause* **5.3** a)] — Substitute the following for the existing:

‘b) *Zinc coated galvanized iron (GI) sheet* — Tube sheet/end plate material shall conform to IS 277.’

[*Page* 4, *clause* **5.3** b)] — Substitute the following for the existing:

‘b) *Aluminium sheet* — Aluminium tube material shall conform to IS 737 or International Standard.’

(*Page* 4, *clause* **6.1**) — Substitute the following for the existing clause:

**‘6.1 Workmanship**

The visual inspection to be carried out for any abnormal scratches, dents as defined in quality management system.

The ends will be covered with caps, plugs or polythene wrapping to prevent any contamination entering in heat exchangers, if stored for more than one day.’

(*Page* 4, *clause* **6.2.1.1,** *para* 2 *and para* 3) — Delete.

(*Page* 4, *clause* **6.2.1.2**) — Delete.

(*Page* 4, *clause* **6.2.1.3**) — Substitute the following for the existing clause:

'**6.2.1.3** *Tube sheet / End plate*

Tube sheet / end plate holes shall be effectively free from interior burrs or sharp edges. Tube sheet / end plate holes sizes shall be defined by the manufacturers in their drawing.'

(*Page* 4, *Table* 1) — Delete.

(*Page* 4, *clause* **6.2.1.4**) — Substitute the following for the existing clauses:

'**6.2.1.4** *Expanded fin tightness*

Tube and fin should be expanded to get firm bonding between fin pack and tubes. With every change in tube specification the bullet size shall be checked to ensure proper bonding between tube and fin pack.'

(*Page* 4, *clause* **6.2.1.5**) — Substitute the following with the existing clause:

'**6.2.1.5** *Brazing material selection*

Brazing material shall confirm to IS 2927 or International Standard.'

(*Page* 4 *clause* **6.2.1.6**) — Delete.

(*Page* 5, *Fig.* 5) — Delete.

(*Page* 5, *clause* **6.2.3**) — Delete.

(*Page* 5, *clause* **7.1.1**, *para* 3) — Substitute '0.000 1' *for* '0.000 0.'

(*Page* 5, *clause* **7.1.2**) — Delete.

(*Page* 6, *clause* **7.2**) — Substitute the following for the existing clause:

**‘7.2 Leak Test**

Each coil shall undergo leak test to conform tightness specification. Leak test method is either water leak test, Helium leak test or vacuum test as described in **7.2.1, 7.2.2** and **7.2.3**.’

(*Page* 6, *clause* **7.2.1**) — Substitute the following for the existing clause:

‘**7.2.1** *Water Leak Test*

All coils shall be subjected to dry nitrogen or dry air with test pressure as design pressure for water leak test purpose.

The test shall be carried as described below:

a) Close one end with dead end plug and provide shut off valve on the other end of the test sample;

b) Connect the coupler to the other end and pressurize charge with dry nitrogen or dry air as specified; and

c) Submerge the coil assemble in water tank and hold for 1 min. Check for the bubble leakage. If no bubble is detected during the inspection, the coil is considered conform.

(*Page* 6, *Table* 2) — Delete.

(*Page* 6, *clause* **7.2.2**) — Substitute the following for the existing clause:

‘**7.2.2** *Helium Leak Test*

Helium is being used as tracer gas, sensitive to detect minute leaks in heat exchanger assemblies. Leak testing shall confirm to IS 9902.’

(*Page* 6, *clause* **7.2.2.1**) — Delete.

(*Page* 6, *clause* **7.2.2**) **—** Substitute the following for the existing clause:

‘**7.2.3** *Vacuum Leak Test Process*

The vacuum leak test shall be carried as follows:

a) All coils shall be subjected to nitrogen purging with test pressure of $500^{+50}_{-0}$ kPa before vacuum leak test for 10 s;

b) Vacuum coupler is to be connected with the test coil; and

c) Vacuum shall be done till the coil pressure reading is in between 0.2 and 0.25 Torr. The mentioned pressure should be achieved in $30^{+10}_{-0}$ s.'

[*Page* 6, *clause* **7.3.1** a) *and* b)] **—** Substitute the following for the existing:

'Heat exchanger shall withstand 3 times the design pressure of the heat exchanger.'

(*Page* 6, *clause* **7.3.1,** *para* 2, *sentence* 2) — Substitute the following for the existing sentence:

'The pressure is to be raised gradually until the highest pressure as above is reached.'

(*Page* 6, *clause* **7.3.2**, *last para*) — Substitute the following for the existing:

'In addition to the above test, heat exchanger shall withstand the 2 times design pressure prior to cycle test and there should not be any visible leak or burst.'

(*Page* 8, *clause* **7.4.5.1**) — Delete.

[*Page* 8, *clause* **7.4.5.2** a)] — Substitute the following for the existing:

'a) The corrosion resistance test to be carried out for to ensure the heat exchanger performs effectively under various atmospheric conditions. The test should be carried out for a minimum 72 h as per the procedure of IS 9844. After completion of test, heat exchanger shall confirm to assembly tightness specification as per **7.2**.'

[*Page* 8, *clause* **7.4.5.2** b)] — Delete.

[*Page* 8, *clause* **7.4.5.2** c)] — Delete.

(*Page* 8, *clause* **8.1**) — Substitute the following for the existing:

'**8.1 Marking of Finned Type Heat Exchanger**

Each finned type heat exchanger for room air conditioners shall be marked with the following:

a) Name of manufacturer;

b) Country of manufacture;

c) Part number; and
d) Date of manufacture.’

(*Page* 8, *clause* **9.1**) — Substitute the following for the existing:

**‘9.1 Type Test**

The type tests shall consist of the tests that would be necessary to check up the performance and characteristics of the units and components.

Type tests shall consist of the following:

a) Internal contamination as per **7.1.1**;
b) Test for mechanical strength as per **7.3**; and
c) Test for corrosion resistance as per **7.4**.’

(*Page* 8, *clause* **9.2**) — Substitute the following for the existing clause:

**‘9.2 Routine Tests**

These shall consist of routine tests that would be conducted on each and every unit during manufacturing/ after completion at the manufacturer’s works.

Routine tests shall consist of the following:

a) Visual Inspection as per **6.1**; and
b) Leak Test as per **7.2.**

NOTE — If a manufacturer produces both heat exchangers and air conditioners, then the leakage test either for heat exchanger or for air conditioner is applicable. In such case leakage test can be conducted as a part of room air conditioner routine test as per IS 1391 (Parts 1 and 2).’

(MED 03)

Publication Unit, BIS, New Delhi, India

# AMENDMENT NO. 2 FEBRUARY 2021

# TO

# IS 11329 : 2018 FINNED TYPE HEAT EXCHANGER FOR ROOM AIR CONDITIONER

## *( First Revision )*

[*Page* 1, *clause* **1** (*see also Amendment No*. 1)] — Substitute the following for the existing clause:

**‘1 SCOPE**

This standard specifies the general requirement and method of tests for finned type heat exchangers used for the manufacturing of room air conditioners up to and including the capacity of 18 000 W.

NOTE — The heat exchanger for air-conditioners other than IS 1391 (Part 1) and (Part 2) is under consideration.’

[*Page* 3, *clause* **5.1** (*see also Amendment No*. 1)] — Substitute the following for the existing clause:

**‘5.1 Tube Material**

The material for the tube shall be of copper or aluminium and shall conform to the relevant standard or Annex as described below:

a) *Copper tube* — Copper tube shall conform to IS 10773 or as per the requirements listed in Annex B.

b) *Aluminium tube* — Aluminium tube material shall conform to Annex C.’

[*Page* 3, *clause* **5.2** a) (*see also Amendment No*. 1] — Substitute the following for the existing :

‘a) *Aluminium fin* — Aluminium fin material shall conform to Annex C.’

[*Page* 4, *clause* **6.1**, line 4 (*see also Amendment No.* 1)] — Substitute ‘72 h’ *for* ‘one day’.

[*Page* 6, *clause* **7.2.1** (*see also Amendment No.* 1)] — Substitute the following for the existing clause:

‘**7.2.1** *Water Leak Test*

All heat exchanger shall be subjected to nitrogen or dry air with a minimum pressure of 2.942 MPa or design pressure as declared by the manufacturer, whichever is lower shall be selected as the test pressure.

Water leak test shall be carried as described below:

a) Close the open ends with dead-end plugs and provide shut-off valve on the other end of the heat exchanger or insert all open connection tubes into the nozzle of the shut-off valve.
b) Connect the coupler to the shut-off valve and pressurize with nitrogen or dry air with a minimum -40°C dew point according to the pressure specified in **7.2.1**.
c) Submerge the heat exchanger in the water tank and hold for 30 s. Check for the air bubbles.

If no bubble is detected during the testing, the heat exchanger is considered to conform.’

[Page 6, *clause* **7.2.2** (*see also Amendment No.* 1)] — Substitute the following for the existing clause:

‘**7.2.2** *Helium Leak Test*

Helium is used as a tracer gas. It is sensitive to detect minute leaks in heat exchanger assemblies.

The leak test is done by the chamber test method or sniffer test method as described below:

a) *Chamber test method:*
    1) Place the heat exchanger inside the chamber and close the door;
    2) Fill the heat exchanger with helium gas at min 1 MPa; and
    3) The leak rate of helium gas from any surface of the heat exchanger shall not be more than $2.51 \times 10^{-5}$ atm-cc/sec ($2.51 \times 10^{-5}$ mbar.l/s).

b) *Sniffer test method:*

1) The heat exchanger is pressurized with helium gas. If required due to large volume, the tracer gas concentration could be 20 percent by volume;
2) Unless otherwise specified, components which are to be pressure leak-tested shall be pressurized to a minimum of 0.42 MPa (60 psi) or 15 percent maximum allowable design pressure, whichever is less, and held at this pressure for sufficient time till equilibrium is reached;
3) The tip of the probe should be within 5 mm of the surface being scanned. Normally a sniffer probe speed of around 25cm/min or less is recommended; and
4) The leak rate of helium gas from any surface shall not be more than $2.51 \times 10^{-5}$ atm-cc/sec ($2.51 \times 10^{-5}$ mbar.l/s).

The correction for the concentration of tracer gas (helium) could be calculated as follows:

$$\frac{\text{Measured leak rate} \times 100}{\text{Percent He Gas}} = \text{Actual leak rate.'}$$

[*Page* 6, *clause* **7.2.3** c) (*see also Amendment No.* 1)] — Substitute the following for existing:

'c) Vacuum shall be done till the heat exchanger pressure reading reaches a maximum of 0.05 Torr. The mentioned pressure shall be achieved within 60 s'.

(*Page* 6, *clause* **7.3,** *line* 4) — Substitute 'burst test or fatigue strength test' *for* 'strength or fatigue strength test'.

(*Page* 6, *clause* **7.3.1**, *para* 2, *sentence* 1) — Substitute the following for existing:

'The test samples are to be filled with non-compressible fluid like water/ oil and are to be connected in a hydraulic pump system/ pressure driving source.'

[*Page* 6, *clause* **7.3.2** (*see also Amendment No.* 1)] — Substitute the following for the existing:

'**7.3.2** *Fatigue Strength Test*

A fresh sample for the cyclic test shall be taken. The heat exchanger shall withstand two times the design pressure for 1 min prior to the cycle test and there shall not be any visible leak, rupture or burst.

The test sample shall be filled with non-compressible fluid like water/ oil and shall be connected to a pressure driving source. The pressure shall be raised and lowered between the upper and lower cyclic values at a rate specified by the manufacturer for a total number of 250 000 cycles. The entire specified pressure excursion shall occur during each cycle.

The following test pressures shall be applied:

a) For the first cycle, the PS for the low-pressure side components or the PS for the high-pressure side components shall be applied;

b) For the test cycles, the upper pressure value shall not be less than 0.7 times design pressure and the lower pressure value shall not be greater than 0.2 times design pressure; and

c) For the final test cycle, the test pressure shall be increased to 1.4 × PS (two times of 0.7 × PS). The pressure shall be 1.8 × PS (two times of 0.9 × PS) for water heat exchangers in the heat pump.

NOTES

**1** For safety purposes, it is suggested to use a non- compressible fluid.

**2** PS (maximum allowable pressure) is the maximum pressure which the system or component is designed, as specified by the manufacturer.

After completion of the fatigue test, the heat exchanger shall withstand min 1.5 times the design pressure for 1 min and there shall not be any visible leak or burst.

[*Page* 8, *clause* **7.4.5.2** a) (*see also Amendment No.* 1)] — Insert the following note at the end of the clause:

NOTE — If the size of the heat exchanger is large and not able to fit into the salt spray chamber, then the manufacturer can prepare a small replica of the heat exchanger (which meets design and process intent) and proceed for salt spray test.

(*Page* 8, *clause* **7.4.5.2,** *last para*) — Delete.

(*Page* 9, *Annex A*) — Insert the following new annexes:

# ANNEX B

( *Clause* 5 )

## COPPER MATERIAL REQUIREMENT

### B-1 CHEMICAL COMPOSITION (wt. percent)

| Elements | C12200 / C1220T |
|---|---|
| Cu | 99.90 *min* |
| Pb | — |
| Sn | — |
| Fe | — |
| Al | — |
| Mn | — |
| As | — |
| Ni | — |
| Zn | — |
| P | 0.015-0.040 |

### B-1.1 Test Method

The sample is dissolved in an acid mixture and the copper is electrolytically deposited and weighted on a tared platinum cathode. Copper remaining in the electrolyte is determined by the atomic absorption spectroscopy method. *See* IS 440 or ISO 1554 for the test method.

### B-2 TENSILE TEST

Performance requirements:

| *Condition* | *Tensile Strength* (Mpa) | *Percentage Elongation* (For wall thickness > 0.508 mm) |
|---|---|---|
| Soft annealed | 205 *min* | 40 *min* |
| Light annealed | 205 *min* | 40 *min* |
| Light drawn | 245-325 | — |

NOTE — The elongation requirements for a copper tube having wall thickness < 0.508 mm shall be as per the agreement between the purchaser and the supplier.

### B-2.1 Test Method

The test shall be carried in accordance with IS 1608 (Part 1) : 2018/ISO 6892-1 : 2016.

## B-3 FLATTENING TEST

Cut the test piece of about 100 mm in length from the tube end. Place the test piece between two flat plates as shown in Fig. 7 and flatten it until the distance between the plates are less than three times the wall thickness of the tube.

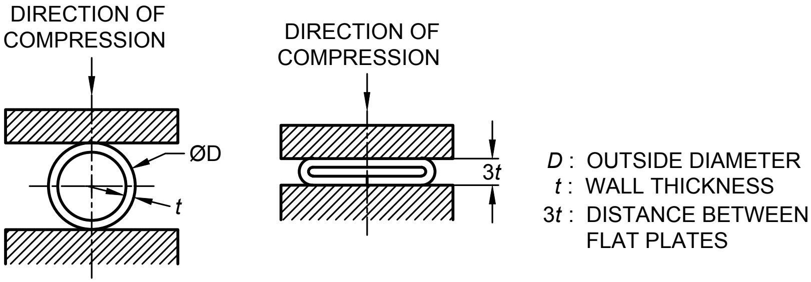

FIG. 7 FLATTENING TEST

### B-3.1 Test Method

The test shall be carried in accordance with IS 2328 : 2018/ISO 8492 : 2013.

### B-3.2 Performance Requirements

The flattened tube shall show no cracks / ruptures through visual inspection without the use of special equipment / enhancement.

## B-4 EXPANSION TEST

Annealed tubes shall be capable of withstanding an expansion of the outside diameter.

Conical mandrel / pin angle = 60°

| *Outer Diameter,* mm | *Expansion*, *min* percent |
|---|---|
| Up to and including 20 | 40 |
| Over 20 - 100 | 30 |

NOTE — This test is not applicable for the inner grooved copper tube.

### B-4.1 Test Method

Test shall be carried in accordance with IS 2335 : 2005/ISO 8493 : 1998.

### B-4.2 Performance Requirements

The expanded shall show no cracks / ruptures through visual inspection without the use of special equipment / enhancement.

## B-5 PNEUMATIC TEST

Each tube shall be capable to withstanding the minimum internal air pressure of 0.4 Mpa for at least 5 s without any leakage.

### B-5.1 Test Method

Test shall be carried in accordance with **10.4.3** of IS 10773.

## B-6 GRAIN STRUCTURE

The grain structure for copper shall be as follows:

| | | |
|---|---|---|
| Light annealed | : | 0.040 mm, *Max* |
| Soft annealed | : | 0.025 - 0.060 mm |

### B-6.1 Test Method

Test shall be carried in accordance with IS 4748 : 2009/ISO 643 : 2003.

# ANNEX C

( *Clause* 5 )

## ALUMINIUM MATERIAL REQUIREMENT

### C-1 MECHANICAL PROPERTIES

### C-1.1 Tensile Strength

The material shall conform to the following requirement:

| Tensile Strength (Mpa) | *Percent Elongation* |
|---|---|
| *Min* 55 MPa | *Min* 1 percent |

### C-1.2 Test Method

The test shall be carried in accordance with IS 1608 (Part 1) : 2018/ISO 6892-1 : 2016.

(MED 03)

Publication Unit, BIS, New Delhi, India